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(54) PHOTOGRAPHIC SIMULATION OF DENSITY DIFFERENCES AS CHANGES OF LINE DIRECTION

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1066109 ABSTRACT OF THE DISCLOSURE NOV 13 1979

The invention relates to a photographic technique for generating a line pattern for use in creating medallion effects on printed documents or for anti-counterfeiting purposes and the like. A high-contrast line screen negative is prepared and a positive generated from the negative. The positive is then superposed on the negative but offset therefrom by the width of a thin line of the resulting image. The combined line pattern creates a medallion effect when the line spacing is comparable in dimensions to the image detail. The resulting pattern may also be used in conjunction with a finding screen or superimposed line pattern to regenerate visual information that appears in hidden or subdued form in the photographic pattern per se.

This invention relates to (1) a method of photographic reproduction of differences in the intensity of light received from an object so as to create a line deflection image, viz. an array of spaced lines in which light intensity differences are recorded as deviations of the lines from a predetermined array, (2) the resultant line deflection image thus created, and (3) a method of simulating a readily perceptible image of the original object by means of superimposition of the predetermined array on the resultant.

BACKGROUND OF THE INVENTION

It is known to use a half-tone screen for the purpose of obtaining a photographic reproduction of an original object suitable for printing. Such half-tone reproductions may be obtained, for example, by interposing a lined glass screen or vignetted contact screen between the object photographed and the camera lens. A high-contrast film may then be used to obtain a negative in which bright areas are reproduced as lines of relatively large width, and dark areas are reproduced as lines having relatively small width. The positive obtained from such negative will simulate, by means of lines of varying width, the contrast of the original object photographed.

It is also known to generate a relief or medallion effect in the printing of an image by means of variations in the direction of lines in a pattern of lines constituting such image. Such effects have typically been created by means of hand engraving by an artisan.

It has also been previously proposed, as an anti-counterfeiting measure in security printing, to create on a printed article a pattern which does not readily convey meaningful information to the unaided eye, but which conveys meaningful information (e.g. readily recognizable image) when a "finding screen" viz. a screen having a predetermined line pattern or the like, is superimposed upon the printed article.

SUMMARY OF THE INVENTION

It is proposed, according to the present invention, to utilize a novel variation of the aforementioned photographic technique to devise a line deflection image. The line deflection image is obtained by combining the negative and offset positive of a high-contrast half-tone image created in accordance with the foregoing half-tone photographic technique. The resultant is a photographically-derived image comprised of lines of varying orientation, which can be used inter alia to generate medallion effects and to generate "hidden" images which become readily apparent to the eye when the images thus created are overlaid by a finding screen having the same line pattern as that through which the original object was photographed.

To this end, the object is first of all photographed in conventional manner on high-contrast film through a line screen to obtain a line negative in which bright areas are reproduced as lines of uniform maximum width and dark areas are reproduced as lines of uniform minimum width. The exposure is arranged so that the lines of maximum width are separated from one another by a distance equal to the width of any of the lines of minimum width. Grey or transition areas are reproduced as tapering lines of width varying from the maximum to the minimum.

A positive of the negative is then developed. The positive is superimposed upon the negative almost exactly in register but with the lines of the positive offset from the lines of the negative through a distance equal to the said minimum width. The result is a line deflection image, viz. a set of spaced lines in which light intensity differences are reproduced as deviations of the lines from the line pattern of the line screen. If the lines of the line screen are of uniform width and spacing, the lines of the line deflection image will be of uniform width.

A line deflection image of a simple object obtained in accordance with the foregoing procedure will frequently create a medallion effect, particularly if the critical dimensions of the object are of the same order of magnitude as the line spacing in the line deflection image. More complex objects having a high information content are reproduced in line deflection image form as line patterns containing only gross visual information. These images when viewed with the unaided eye do not seem to contain more than a minimum of information. However, if a lined transparency having the same line pattern as that of the line screen pattern used to create the negative from which the line deflection image was obtained is superimposed upon the line deflection image, all of the detail of the half-tone photographic reproduction is revealed to the observer.

The invention is thus seen to afford a relatively simple photographic technique for (a) simulating medallion effects and (b) generating "hidden" images whose information content is revealed when a finding screen is superimposed thereon. Heretofore these effects had to be generated by relatively laborious manual techniques.

A special application of the invention lies in the generation of coloured transitory image patterns of the type described and claimed in Canadian Patent No. 1,019,012 entitled COLOURED TRANSITORY IMAGES IN PRINTED ARTICLES (R. Gordon Hutton and Trevor Merry) which issued on 11 October 1977.

Reference has been made herein to "lines". By a "line" is meant a continuous narrow visual effect, whether constituted by an absolutely continuous line or by series of dots or spaced line segments. Conveniently, the line screen used to generate the high-contrast negative from which the line deflection image is obtained is a ruled parallel straight line screen. However, it could conceivably be comprised of a system of non-parallel straight or curved lines. Indeed, for some anti-counterfeiting purposes it may be useful to employ a more complex line screen pattern than the convenient simple parallel line pattern.

The invention is a method of generating a line deflection pattern, comprising

developing line-screen high-contrast negative and positive photographic representations of an object in which bright areas are represented in the negative by relatively thick lines of generally uniform width and in the positive by relatively thin lines of generally uniform width, dark areas are represented in the negative by relatively thin lines of generally uniform width and in the positive by relatively thick lines of generally uniform width, and grey areas are represented in both the negative and the positive by transitional line areas in which the width of the line varies from the width of the said thin lines to the width of the said thick lines, and

wherein the thin lines of the negative are of substantially the same width as the thin lines of the positive and the thick lines of the negative are of substantially the same width as the thick lines of the positive; and

offsetting the negative with respect to the positive in a direction generally perpendicular to the direction of extension of the lines through one thin line width while otherwise maintaining alignment of the negative with the positive.

SUMMARY OF THE DRAWINGS

Figure 1 is a schematic greatly magnified partial view of a high contrast negative of a parallel-line screened object.

Figure 2 is a schematic magnified view of a corner portion of a high-contrast negative of a parallel-line screened object.

Figure 3 is a schematic magnified view of a corner portion of a positive obtained from the negative of Figure 2.

Figure 4 illustrates the manner in which the positive of Figure 3 is offset from and superimposed upon the negative of Figure 2 to obtain a line deflection image in accordance with the teachings of the present invention.

Figure 5 is an object composed of relatively simple visual elements.

Figure 6 is a line deflection image of the object of Figure 5.

Figure 7 is a line deflection image obtained from a relatively complex object, viz. the photographic portrait of a woman.

Figure 8 is a regular arrangement of straight parallel lines having the same frequency as the lines of the screen used to generate the line deflection image of Figure 7.

Figure 9 illustrates the result of superimposing the line arrangement of Figure 8 upon the line deflection image of Figure 7.

Figure 10 is a schematic greatly magnified view of a portion of a line screen comprised of non-parallel straight lines.

Figure 11 is a schematic greatly magnified partial view of a high-contrast negative obtained from an object photographed through a line screen comprised of non-parallel straight lines.

Figure 12 is a schematic magnified view of a portion of a line screen comprised of wavy lines.

Figure 13 is a schematic greatly magnified partial view of a high-contrast negative obtained from an object photographed through a line screen comprised of wavy lines.

DETAILED DESCRIPTION WITH REFERENCE TO DRAWINGS

Figure 1 is a small portion of a line negative of an object showing only a greatly enlarged detail of two adjacent exposed areas 11, 13 on the negative. These lines each comprise, in that portion seen in Figure 1, a narrow portion (11a, 13a), a tapering portion (11b, 13b) and a wide portion (11c, 13c) respectively. Portions 11a, 13a represent areas of low-light intensity, areas 11c and 13c represent relatively bright

areas, and areas 11b, 13b represent transition areas (grey areas) between light areas and dark areas. These line-type reproductions may be conventionally obtained on high-contrast lithographic film (for example the film manufactured by the Eastman-Kodak Company under the trade mark Kodalith), by means of photographing the object through a lined glass screen, vignetted contact screen or the like. The film and exposure are selected so that the separation distance b between adjacent dark areas 11c, 13c is equal to the width b of the narrow exposed areas 11a, 13a. It follows that the narrow areas 11a, 13a are separated by a distance a equal to the width a of a wide line area 11c, 13c.

In Figure 2, a line negative 19 obtained in the above manner has a plurality of adjacent dark lines 21, 23, 25, 27 and 29. Figure 3 shows a portion of the positive 32 of the negative of Figure 2, and thus it shows the dark line (exposed) areas 21 etc. of the negative 19 reproduced as white line or empty space areas 31, 33, 35, 37, 39. If the positive of Figure 3 is then superimposed upon the negative of Figure 2 with the upper left corner point 30 of the positive arranged to lie below the upper left corner point 20 of the negative by the distance s between adjacent lines of the positive (i.e. the width s of a dark line of minimum thickness of the negative corresponding to an unexposed area) then the resultant of the Figure 4 is obtained. In this Figure, a plurality of lines 41, 43, 45, 47, 49, etc. of uniform width but of varying contour are obtained. It will be observed that the change in contour of the lines 41, 43, 45, 47, 49, etc. occurs at exactly the areas of transition at which the wide portions of the lines on the negative converge to narrow lines (i.e. at the grey areas where bright area wide lines converge to dark area narrow lines).

In other words, changes in density have been transformed via the procedure just described to changes in line orientation or contour. The resultant of Figure 4 may conveniently be described as a line deflection image, which is the term used herein.

Figures 5 and 6 illustrate the results of the aforementioned technique. Figure 5 is a subject which contains a relatively broad dark or black area 51, a broad bright or white area 53, a broad grey area 55, and some finer detail, namely the legend "$5000". Figure 6 is a line deflection image of Figure 5. It can be observed that at the transition points between those areas of Figure 5 of differing brightness, a line deflection occurs in the line deflection image of Figure 6. The effect for the broad areas is to generate, by means of the visual continuity of the points of line deflection, a visual outline of the broad shapes (triangular and square) of Figure 5.

The effect for the finer detail is somewhat different and surprising. If the spacing of the lines in the line deflection image is chosen to be of the same order of magnitude as the widths of areas constituting a visually significant portion of a subject, the line deflection image generates a relief or medallion effect in respect of such areas. This effect is apparent in Figure 6 in respect of the line deflection image reproduction of the "$5000" legend. The relief or medallion effect of the Figure 6 reproduction of the legend will be enhanced for at least some observers by viewing the Figure at an angle or increasing the distance between the eye and the Figure.

It is thus seen that the invention affords a simple means of generating photographically medallion effects which

heretofore have been generated conventionally by hand engraving or the like.

Where the detail of the subject is appreciably finer than the spacing of the lines in the line deflection image, the visually apparent information content of the line deflection image is relatively low, but can be made visually apparent by the superimposition on the line deflection image of a finding screen whose line pattern is the same as that of the vignetted screen or the like which was used in the creation of the negative from which the line deflection image was obtained. To illustrate the foregoing, Figure 7 is a line deflection image of the portrait of a woman, which can be seen to have relative low information content. The overall view can barely be recognized as one resembling the portrait of a woman. The line deflection image of Figure 7 was prepared using a straight parallel line screen (Figure 8). When the parallel line screen of Figure 8, whose line spacing is equal to the average line spacing of Figure 7, is superimposed upon the line deflection image of Figure 7, a startling result is achieved. Figure 9 illustrates the resulting superimposition of the parallel line screen of Figure 8 on the contour line array of Figure 7. It can be seen that the result of this superimposition is to make apparent to the observer all of the latent information content of Figure 7.

The alignment of the line deflection image of Figure 7 with the screen of Figure 8 must be carefully selected to obtain a positive. If the screen of Figure 8 were shifted transversely through the distance between adjacent lines, then a negative instead of a positive image would have appeared in Figure 9.

Figure 8 may be considered a "finding screen" for the line deflection image of Figure 7. If, for example, the line deflection image of Figure 7 had been printed on a security document such as a bank note or share certificate, the superimposition by an observer of the finding screen of Figure 8 (which may for example take the form of parallel dark lines printed on a plastic transparency) on the document would reveal the hidden image and thus tend to confirm that the document was genuine. Departures from accuracy in the reproduction of the line deflection image (by counterfeiters, say) would tend to become accentuated in the visual effect obtained by superimposition of the finding screen on the reproduction, and thus detection of a counterfeit may be faciliatated through the use of the invention. Furthermore, if the line deflection image itself is not readily apparent on the document, as can easily be devised through "camouflaging" of the image by other art work on the document, a counterfeiter may not know that a line deflection image is present, and may not recognize the importance of accurate reproduction of the fine detail on the document.

A special use of the present invention lies in the generation of coloured transitory images of the type described in copending Canadian Patent No. 1,019,012 - Hutton and Merry entitled "Coloured Transitory Images in Printed Articles", which issued on 11 October 1977. In that patent, disclosure is made of printed articles bearing alternating coloured lines of two different colours which are selectively occluded by embossed lines in the articles so as to cause changes in visual effects as the angle of view of the article is varied. A recognition pattern appears as a transitory image which can be generated by offsetting or phase-shifting the alternating coloured line arrangement in the recognition pattern area with respect to the

alternating coloured line arrangement in the background. Alternatively, the coloured line arrangement may be uniform throughout and the recognition pattern generated by off-setting the embossed lines in the recognition pattern area with respect to the embossed lines in the background. In either case, a line deflection image according to the present invention can be prepared of the desired recognition pattern, and the line deflection image then used to generate either the coloured line arrangement or the embossed line arrangement on the printed article. (The line deflection image of Figure 6, for example, could be used to reconstruct as a transitory image the recognition pattern of Figure 5.)

If the line deflection image is reproduced as the coloured line pattern, then the embossed line image required to complement the coloured line image on the printed article should be generated as the equivalent of the "finding screen" complementing the line deflection pattern in question. Similarly, if the line deflection pattern is reproduced on the printed article as a pattern of embossed lines, then the coloured line pattern on the printed article should be equivalent to the complementary finding screen for that particular line deflection pattern. The lines of the line deflection pattern in either case should extend in generally the same direction as the lines of the complementary pattern, but need not be exactly in register. The effects of generating the two patterns on the documents slightly out of register so as to create moiré effects and the like is discussed in further detail in the aforementioned Canadian Patent No. 1,019,012.

If the line deflection pattern is used to generate the embossed line pattern on the printed article, then the object photographed should include some low contrast areas

so that there will be a phase shift of less than one embossed line width in the resulting line deflection pattern. As described in more detail in Canadian Patent No. 1,019,012, a phase shift of less than one embossed line width is required in order to produce the satisfactory transitory image. On the other hand, if the line deflection pattern is used to generate the coloured line pattern, then object photographed to generate the line deflection pattern should include some high contrast detail. This would give the maximum line deflection and thus would be approximately a deflection of about one coloured line width. This condition is also required for the reproduction of good transitory images as described in greater detail in Canadian Patent No. 1,019,012. The difference in the two approaches for the embossed line pattern on the one hand and the coloured line pattern on the other is of course explained by the fact that the embossed line frequency is one-half the coloured line frequency (the embossed line frequency is the same as the line frequency of either one of the colours but since the two colours alternate, the total line frequency is double that of the embossed line frequency).

An example of a high contrast detail is represented in Figure 5 by the black and white triangular areas, which give rise to maximum line deflection as appears from Figure 6. An example of low contrast detail is exemplified in Figure 5 by the transition between the white triangle and the grey background or between the black triangle and the grey background. It can be seen by referring to Figure 6 that the line deflection going from the background area to either the black triangle or the white triangle is less than

the line deflection going from the white triangle to the black triangle.

The pattern of lines used for generating the negative (or as a complementary screen) need not be a pattern of parallel straight lines. Figures 10 and 12 show respectively a pattern of converging straight lines and a pattern of regular wavy lines, each of which could be used to achieve essentially the same kind of resulting line deflection image.

Figure 10 shows as a pattern for the line screen (or complementary finding screen), a pattern of converging lines (shown in greatly magnified portional view in Figure 10). A portion of the further magnified converging line pattern of a representative negative obtained from such line screen is illustrated in Figure 11. The extent of convergence is, within limits, arbitrary, but over a six-inch length of printed document, a variation from 60 lines per inch to 100 lines per inch is representative. The angle of convergence in Figures 10 and 11 is exaggerated for purposes of illustration. The opaque and transparent areas of the screen of Figure 10 would be of equal (but different) widths at each end of the screen and would taper uniformly from one end to the other. Again, in Figure 11, the bright areas of the object photographed appear as thick opaque lines 111 and the darker areas of the object photographed generate only relatively narrow opaque lines 113. The production of a positive from the negative is obtained in the manner previously described, and the composite line deflection image is again obtained by shifting the positive through a distance b, variable over the length of the pattern, equal to the width of a narrow line 113 at every point along the length of the

converging line system. This means that, for example, if at one end of the document the lines occupy 1/60 of an inch and at the other end, the lines occupy 1/100 of an inch, then at the first end of the document, the positive would be displaced with respect to the negative by 1/60 of an inch, and at the other end of the document would be displaced by 1/100 of an inch with respect to the negative.

The above result can be obtained in a different way without using the line screen of Figure 10 and the negative of Figure 11. Instead, the parallel line screen, negative and positive described with reference to Figures 1 to 4 and 8 can be used to generate a line deflection pattern as previously described. Then the line deflection pattern and line screen can be subjected to optical distortion (as by inclining the object with respect to the camera) to generate a converging line deflection pattern and finding screen.

Referring to Figure 12, the wavy line pattern to be used to generate the negative comprises alternate opaque and transparent wavy lines of uniform thickness. Again, the pattern is presented in greatly magnified portional view. A portion of a representative resulting negative is illustrated in Figure 13 in further magnified view. The bright areas of the object photographed generate relatively wide opaque areas 91 on the high contrast film, whereas the darker areas of the object photographed generate only relatively narrow opaque lines 93. A positive can be made, in the same manner described previously, from the negative of Figure 13. The positive and negative are then combined with the positive offset from the negative through a distance b representing the thickness of one of the narrow lines 93 of Figure 13, so as to generate a resultant line deflection image in which

the variations resulting from changes in contrast appear as deflections from the basic wavy line pattern.

The resultant line deflection image derived from any of the aforementioned line screen patterns can be characterized as comprising latent visual information superimposed upon a basic pattern of lines. The latent information can be considered to comprise differential dark areas which when "added" to a superimposed complementary finding screen yield a resultant total visual effect conveying relatively high information content to the eye. The information content is disguised by the fact that the differentials or variations are present in a line pattern that, in the absence of the dark areas contributed by the finding screen, does not appear to the eye to have the same degree of information content. The reason for this apparently is that it is very difficult, sometimes virtually impossible, for the mind or the eye to perform the addition without the actual presence of the finding screen.

Variations in the techniques described above may occur to those skilled in the art. The scope of the invention is not to be considered limited by specific examples discussed above but is as set forth in the appended claims.

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. A method of generating a line deflection pattern, comprising

developing line-screen high-contrast negative and positive photographic representations of an object in which bright areas are represented in the negative by relatively thick lines of generally uniform width and in the positive by relatively thin lines of generally uniform width, dark areas are represented in the negative by relatively thin lines of generally uniform width and in the positive by relatively thick lines of generally uniform width, and grey areas are represented in both the negative and the positive by transitional line areas in which the width of the line varies from the width of the said thin lines to the width of the said thick lines, and wherein the thin lines of the negative are of substantially the same width as the thin lines of the positive and the thick lines of the negative are of substantially the same width as the thick lines of the positive; and

offsetting the negative with respect to the positive in a direction generally perpendicular to the direction of extension of the lines through one thin line width while otherwise maintaining alignment of the negative with the positive.

2. A method as defined in Claim 1, additionally comprising reproducing said line deflection pattern on a substrate.

3. A method as defined in Claim 2 wherein the substrate is flat.

4. A method as defined in Claim 3 wherein the lines of the negative and positive are spaced from one another by the distance which is of the same order of magnitude as the dimensions of at least some of the detail in the object, whereby such detail

is reproduced on the substrate as a medallion-like image.

5. A method as defined in Claim 3, comprising reproducing the line deflection pattern as an embossed pattern on a substrate on which is printed a two colour line pattern in which the coloured lines are of alternating colours and of substantially uniform spacing and width and of substantially the same line frequency, for any one colour, as the line frequency of the line deflection pattern, and wherein the lines of the line deflection pattern extend in generally the same direction as the lines of the coloured pattern.

6. A method as defined in Claim 5 wherein one set of coloured lines is the background colour of the substrate and the other set of coloured lines is printed on the substrate.

7. A method as defined in Claim 5 wherein the object from which the negative and positive photographic representations were obtained to form the line deflection pattern comprises at least some low contrast detail.

8. A method as defined in Claim 3 comprising reproducing the line deflection pattern as a pattern of coloured lines of alternating colours on said substrate, and embossing said substrate either before or after the reproduction of the line deflection pattern with a pattern of embossed lines of substantially uniform width and spacing and of the line frequency equal to the line frequency of either of the two colours of the line deflection pattern, and wherein the embossed lines extend in generally the same direction as the lines of the line deflection pattern.

9. A method as defined in Claim 8 wherein the object from which the photographic representations were made to form the line deflection pattern comprises at least some high contrast

detail.

10. A method as defined in Claim 9 wherein the photographic representations are obtained by photographing the object through a line screen, and wherein the embossed line pattern is of generally the same configuration as the line screen.

11. A method as defined in Claim 7 wherein the negative and positive photographic representations are obtained by photographing the object through a line screen, and wherein the coloured line pattern is of generally the same configuration as the line screen.

12. A method as defined in Claim 3 wherein the line screen photographic representations have been obtained by photographing the object through a parallel line screen.

13. A method as defined in Claim 3 wherein optical distortion of the line pattern is effected by placing a distorting medium between the film and the object.

14. A method as defined in Claim 3 wherein the line screen photographic representations have been obtained by photographing the object through a wavy line screen.

15. A method as defined in Claim 3 wherein the line screen photographic representations have been obtained by photographing the object through a converging line screen.

16. A method as defined in Claim 3 wherein the photographic representations are taken through a parallel line line screen placed at an oblique angle to the film whereby the resulting negative and positive photographic representations comprise generally converging line patterns.

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Applicant

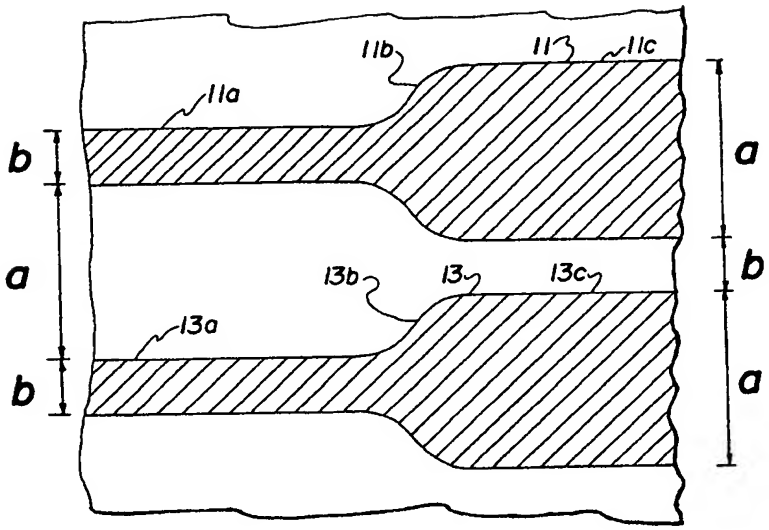

FIG. 1

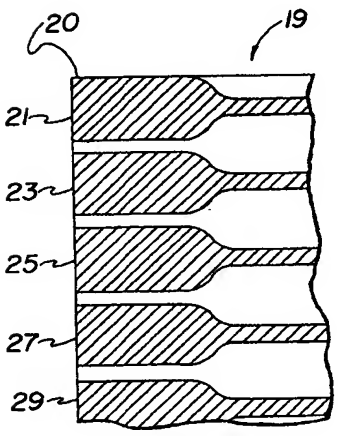

FIG. 2

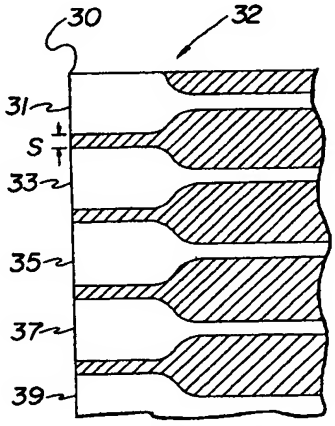

FIG. 3

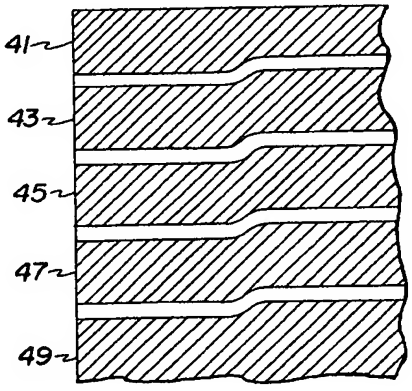

FIG. 4

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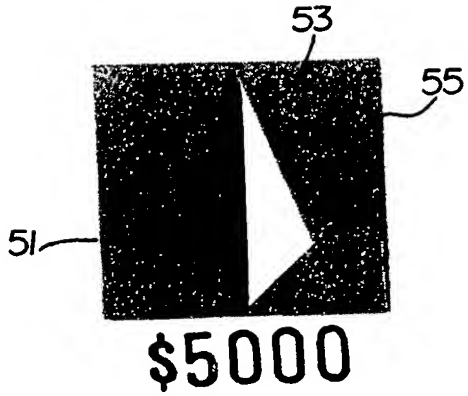

FIG. 5

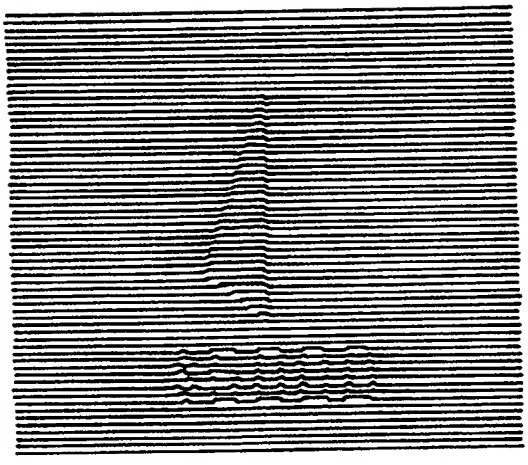

FIG. 6

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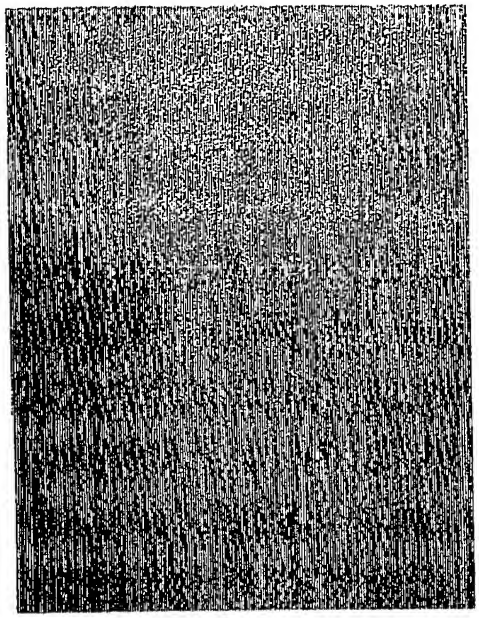

FIG. 7

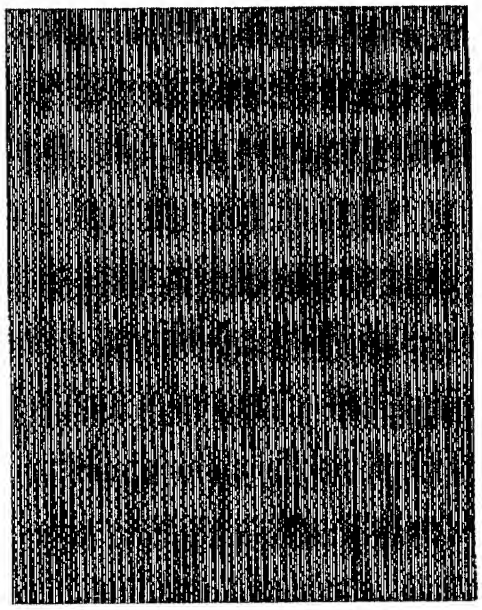

FIG. 8

FIG. 9

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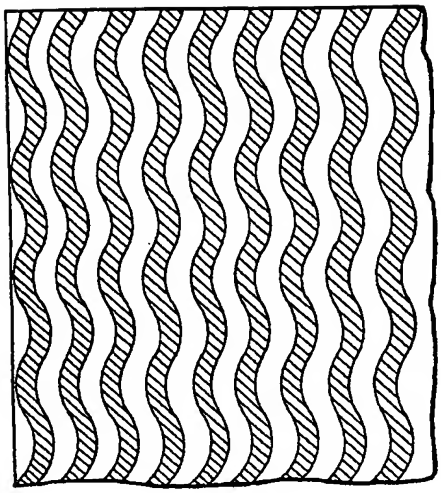

FIG. 12

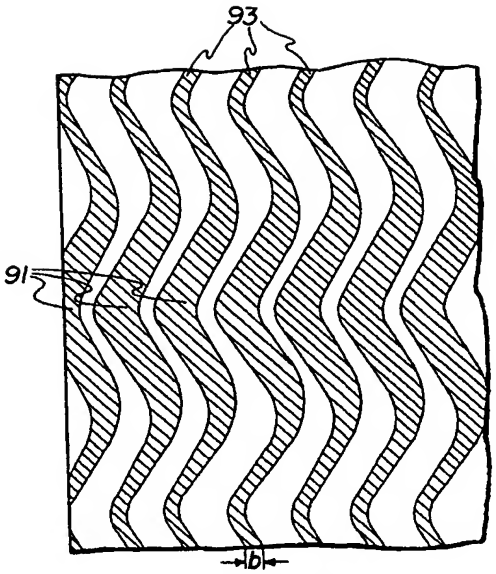

FIG. 13

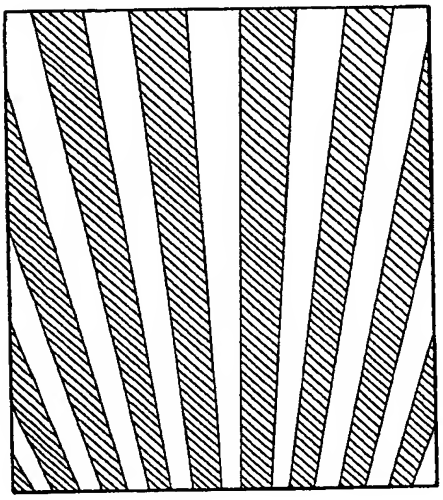

FIG. 10

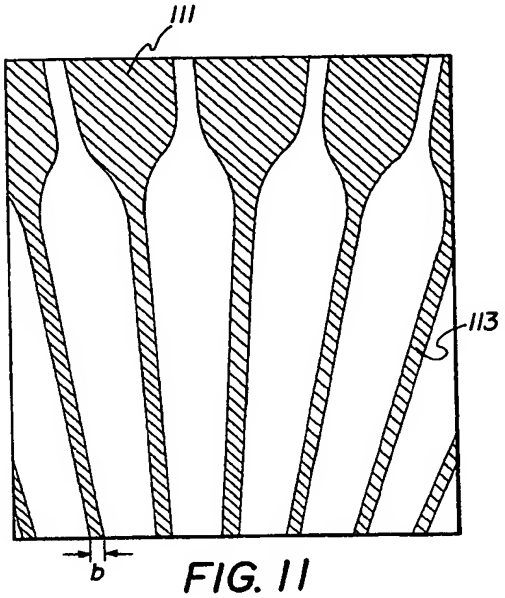

FIG. 11

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